Relativistic Heavy Ion Collider
Magnet Division Procedure

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Class: CQ13
Title: 13cm Quadrupole and Corrector Shell and End Plate Welding

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REVISION RECORD

Rev. No.	Date	Page	Subject	Approval	QA	ES&H
A	7/12/93		Initial Release.			
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1. Scope:

This specification establishes the procedure for manual shell welding and end plate welding on RHIC 13cm Insertion Quadrupole and 13cm Corrector magnets.

2. Applicable Documents:

The following documents of the issue in effect as of the date of this specification, form a part of this specification to the extent specified herein:

2.1 RHIC Specifications

RHIC-MAG-R-7320	RHIC Electrical Resistance Measurement For Collared Individual Coils and Connected Coil Sets
RHIC-MAG-R-7228	RHIC Magnet Coil Inductance and Q Measurements
RHIC-MAG-R-7242	RHIC Hypot Testing
RHIC-MAG-R-7243	RHIC Low Precision Resistance/Continuity/Insulation Test
RHIC-MAG-R-7010	RHIC Welder Qualification
RHIC-MAG-Q-1004	Discrepancy Reporting System
RHIC-MAG-R-8792	Removal of Cold Mass Twist

2.2 RHIC Magnet Assembly Drawings

12020017	13cm Q1 Yoke Containment Assembly
12020505	13cm Q2 Yoke Containment Assembly
12020488	13cm Q3 Yoke Containment Assembly
12040304-01,-02	CRI, CRJ Corr. Shell/End Plate Weld
12040305-01,-02	CRM, CRL Corr. Shell/End Plate Weld
12040288	CRK Corrector Half Shell Welding
12050381-01,-02	CQ3 LE End Plate Weld/LE Corr. Join

2.3 Tooling Drawings

25-1361.06-5	13cm Q1 Pre-Production Cradle Assembly Rework
25-1361.21-5	Lead End Plate Positioning Fixture
25-1361.22-5	Non-Lead End Plate Positioning Fixture
25-910.01-5	Shell Welding Fixture

3. Requirements:

3.1 Safety Precautions

3.1.1 Welding operations shall be conducted in Designated Cutting/Welding Areas or with a welding permit. Failure to observe these safety precautions may result in fire.

3.1.2 No welding shall take place unless all welding screens are in place around the welding station, and all personnel not directly involved with the welding process are outside the screens. Any personnel inside the screens shall wear protective gear to prevent eye injury, and shall be clothed to prevent burns caused by intense ultra-violet light.

3.1.3 The technicians shall be qualified by their cognizant technical supervisor in the operation of the required electrical test equipment and the electrical testing procedures. They shall be familiar with the latest revisions of the applicable documents referenced in Section 2. In addition, some of these tests require the technician to have special training.

3.1.4 Some of the electrical test procedures have specific safety requirements. The technicians performing these specific tests shall rigorously follow all the safety requirements listed as well as those prescribed by the BNL ES&H Standard.

3.1.5 Hypot and impulse testing pose a Class "C" electrocution hazard. At least two properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point where the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading "DANGER HIGH VOLTAGE" and warning lights shall be turned on.

3.1.6 Hard hats are required when the overhead crane is in use. Failure to observe this caution may result in head injury.

3.1.7 All lifting and handling operations requiring use of the overhead crane shall be performed by holders of valid Safety Awareness Certificates and have received training on the use of the lifting device being used by the Cognizant Engineer or Technical Supervisor.

3.2 Procedure:

3.2.1 Electrical Testing the 13cm Quadrupoles

NOTE

In all 13cm insertion quadrupoles, the eight exiting leads have been rotated 90^0 clockwise in the spiral assembly (see Fig. 1).

3.2.1.1 Electrically connect the leads of diagonally opposing coils.

3.2.1.2 Perform an ohmmeter check of the resistance between the two pairs of coils, following RHIC-MAG-R-7243. Verify that the resistance is at least 20 megohms.

CAUTION

The "Hypot" test is to be conducted only by trained and certified personnel. Be sure the "Hypot" and yoke are grounded at all times. Failure to observe this caution may result in electrocution.

3.2.1.3 Perform a coil-to-coil hypot check at 3 kV following RHIC-MAG-R-7242. Record the leakage current in the traveler.

NOTE

The leakage current must be less than 50µa.

3.2.1.4 Electrically connect the main coil leads together. Perform an ohmmeter check of the resistance between the main coils and the yoke, following RHIC-MAG-R-7243. Verify that the resistance is at least 20 megohms.

3.2.1.5 Perform a hypot check between the main coils and the yoke at 5 kV, attaching the grounded lead of the hypot tester to the yoke, following RHIC-MAG-R-7242. Record the leakage current in the traveler.

NOTE

The leakage current must be less than 50 µa.

3.2.1.6 Measure voltage drops across each individual coil at 1 amp DC, following RHIC-MAG-R-7320.

3.2.1.7 Measure inductance (L) and quality factor (Q) of individual coils per RHIC-MAG-R-7228.

3.2.1.8 Append completed electrical data sheets to the traveler.

3.2.2 Assembly of Shell to Yoke

NOTE

All welding and weld procedures are to be performed by welders qualified per RHIC-MAG-R-7010.

3.2.2.1 Set-up the welding fixture for tacking the first shell while the cold mass is supported continuously atop support rails which engage the yoke survey flats.

3.2.2.2 Use lifting tongs to pick-up the yoke assembly (rotated 90^0 so that the yoke midplane is vertical) and place it on the support rails of the welding fixture. Use two sets of lifting tongs to handle a corrector assembly, at least three sets of equally spaced lifting tongs to handle a Q1 or Q3 collared coil assembly, and no less than four sets of equally spaced lifting tongs whenever handling a Q2 collared coil assembly.

NOTE

Before proceeding with quadrupole shell welding, be certain that the spiral assembly is installed at the lead end and that the stainless steel coil pressure plates are installed at both ends of the collared coil.

3.2.2.3 Place the two weld backing strips in their slots. Locate them lengthwise symmetrically relative to the coil pressure plates in the quadrupoles but in the case of the correctors, position the strips in accordance with the dimensions shown on the applicable engineering drawing. While holding the strips firmly against the upper edge of the slot, tack weld first the top followed by the bottom edge of the strips to the yoke iron every 6" (bottom tack in line with top tack). Tacks shall be minimal (1/4 in. max.).

3.2.2.4 Place a half shell over the iron, locating it lengthwise symmetrically relative to the coil pressure plates of the quadrupoles (located specifically per the applicable engineering drawings in the case of the correctors). Center it circumferentially relative to the yoke by measuring the height from the weld fixture base plate to the shell edges. Clamp the yoke/shell assembly firmly in place against the support rails.

NOTE

Important! In the case of the "K"-Style correctors, only one half-shell shall be welded at this time. The second half-shell will be installed after the Q3 quadrupole extension bus is fitted through the corrector bus slot. Refer to the applicable engineering drawing (12040288).

NOTE

For 13cm correctors use two clamps. For Q1 use three equally spaced clamps. For Q3 use four equally spaced clamps. For Q2 use five equally spaced clamps.

3.2.2.5 Tack weld the half shell to the back-up strips using Type ER385L wire. A C-clamp may be used to squeeze in the edges when tacking. Tacks shall be 2" long spaced every 6". Utilize two certified welders operating simultaneously, with one on each side of the cold mass progressing in-step along the length.

3.2.2.6 Using two certified welders, one on each side, operating in-step, continuous fuse weld the bottom of the backing strip to the iron yoke. Add filler wire only where necessary and do not allow the fuse weld to protrude above the iron O.D.

NOTE

Important! In the case of the "K"-Style corrector units only, stop at this point! The second shell shall not be welded at this time. The second shell will be installed after the Q3 quadrupole extension bus is fitted through the corrector bus slot during the joining operation. Refer to the applicable engineering drawings for details.

3.2.2.7 Using lifting tongs which hook under the edge of the upper shell, remove the magnet from the fixture. Place magnet on rollers and rotate 180□.

3.2.2.8 Install moveable foot pads onto the straight rails, positioning them so that they penetrate the shell at the required hole locations.

NOTE

Two pairs of foot pads are required for the Q1 and corrector units, three pairs for Q3, and four pairs for Q2.

3.2.2.9 Return the cold mass to the welding fixture, resting the yoke survey flats on the foot pads. Place the second half shell over the yoke, adjusting it lengthwise to line up with the first half-shell and balancing the weld gap on both sides.

3.2.2.10 Clamp the shell firmly in place using the same clamping scheme as in paragraph 3.2.2.4.

3.2.2.11 Using two certified welders remaining in-step along the length, tack weld the two half shells together using Type ER385L wire. A C-clamp may be used to draw in the edges of the second half shell. Tacks shall be at the same locations as the bottom shell.

3.2.2.12 Using two certified welders remaining in-step along the length, start at the lead end and make a root pass using Type ER385L wire. End the shell weld two inches back from the end of the yoke laminations at both ends of the magnet in order to be able to slide on the endplate later.

3.2.2.13 Using two certified welders remaining in-step along the length, start at the lead end and make a cover pass using Type ER385L wire. Again, be sure to stop the weld two inches back from the end of the yoke at both ends.

3.2.3 End Plate Installation Procedure:

NOTE

Proper installation and preloading of the quadrupole set screws requires that a clean work area be maintained. The ends of the magnet must be free of all manner of debris. Vacuum all dust, shavings, etc., from the end of the magnet before installing the endplates.

3.2.3.1 Rotate the magnet back to its normal top-up position (yoke midplane horizontal). Transfer it to the end plate assembly fixture and support it on two pairs of foot-pads for the Q1 quadrupole, Q3 quadrupole and all but the K-style correctors, and four sets of foot pads for the Q2 quadrupole and CQ3 lead end (K-style) corrector after it has been joined to the Q3 quadrupole.

3.2.3.2 Using the endplate positioning fixtures at the lead and non-lead ends, fit the endplates into their correct position and set the assembly length to allow for weld shrinkage. For rotary MIG welding, assume 1/16 in. shrinkage per end plate weld. If manual TIG welding is necessary, assume 1/8 in. shrinkage per end plate weld. The shell/endplate weld root gap can vary anywhere from .05" to .15". Where possible, set both end plate weld root gaps equally at each end.

3.2.3.3 Install four .25 diameter copper rods through the four heater holes when welding the end plates in order to prevent weld seepage from restricting the heater cavity.

NOTE

Before welding the corrector end plates, always protect the exiting power leads from overheating and burning by covering them with two overlapping Nomex split corrugated tubes.

3.2.3.4 Tack weld each endplate to the shell at eight equally-spaced locations. Use a crisscross tacking pattern to minimize cocking. Re-verify proper endplate position.

3.2.3.5 Unbolt the positioning fixture from each end plate. Use lifting straps to lift the magnet from the welding fixture and transfer it to the welding station.

3.2.3.6 Lower the cold mass onto the rotary MIG fixture, make the necessary adjustments and rotary MIG weld the end plate(s) using strictly ER385L filler wire.

NOTE

When welding the lead end plate on the K-Style corrector (after joining to CQ3) be sure to protect the top of the quadrupole extension bus with extra Nomex strips to prevent burning the G-10 housing. Also, lay a protective TIG root pass to this area using minimal heat (by progressing slowly and pausing often to allow cooling down) in order to shield the bus from overheating during the addition of subsequent weld passes.

3.2.3.7 If manual welding is necessary, lay in a circumferential TIG root pass to weld the end plate(s) to the shell. Then complete the welding with 1 or 2 more TIG passes as required. Use Type ER385L filler wire.

3.2.3.8 Complete longitudinal seam welding of shell adjacent to the end plate(s).

3.2.3.9 (Quads Only): While the cold mass rests on rollers, measure the axial twist using the twist bridge equipped with electronic inclinometer. Take measurements at all available upper shell hole locations.

3.2.3.10 (Quads Only): Compute the standard deviation of the inclination values. If the standard deviation exceeds 0.5 milliradians, apply corrective welds to the shell per RHIC-MAG-R-8792 to reduce the twist to within 0.5 milliradians rms.

NOTE

The rms (root-mean-square) value is the same as the standard deviation.

3.2.4 Quadrupole Set Screw Torque Procedure

3.2.4.1 Allow sufficient time for end plate welds to cool to the touch. Install the sixteen pressure plate set screws into the end plates (coat with Loctite 242 prior to installation). Torque them to the prescribed value indicated on the applicable yoke containment assembly drawing. Use a crisscross torquing pattern and proceed in 20 in.-lb. increments up to the final value and then go around twice more to set the final torque.

3.2.4.2 Measure and record overall length (end plate-to-end plate in the case of the quadrupoles, end plate to opposite shell end in the case of the correctors and CQ3).

3.2.5 Final Electrical Testing after End Plate Welding (Quadrupoles)

3.2.5.1 Repeat quadrupole electrical checks per paragraphs 3.2.1.1 - 3.2.1.8.

4 Quality Assurance Provisions:

4.1 The Quality Assurance Provisions of this specification require compliance with the procedural instructions specified herein.

4.2 The technician is responsible for notifying the technical supervisor and/or the cognizant engineer of any discrepancies occurring during the performance of this procedure. All discrepancies shall be identified and reported as per RHIC-MAG-Q-1004.

5 Preparation for Delivery:

N/A

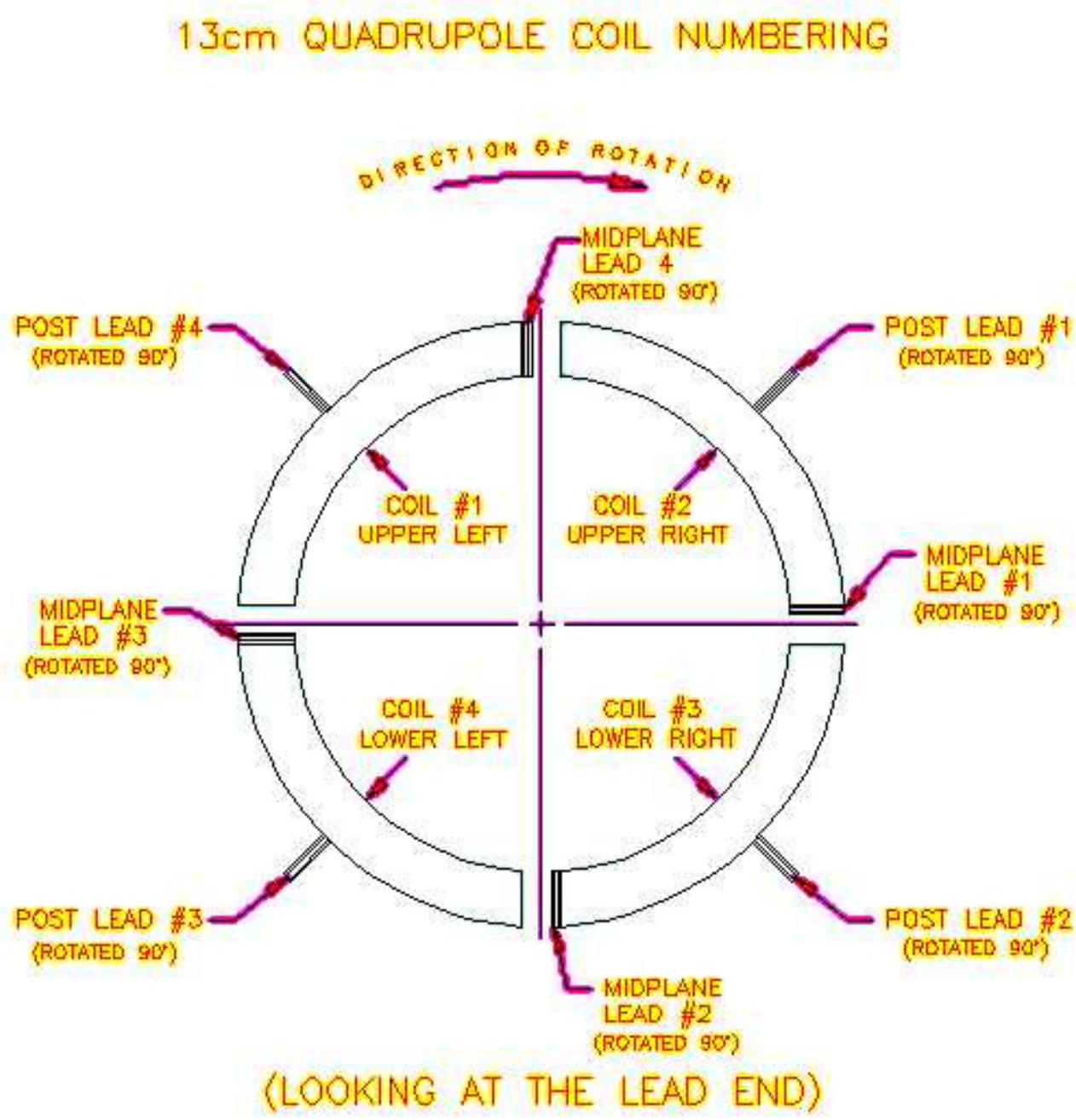

FIGURE 1